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Cost-effectiveness of a specialist smoking cessation package compared with standard smoking cessation services for people with severe mental illness in England: a trial-based economic evaluation from the SCIMITAR+ study

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ABSTRACT

Aims To evaluate the cost-effectiveness of a specialist smoking cessation package for people with severe mental illness **Design** Incremental cost-effectiveness analysis was undertaken from the UK National Health Service and Personal Social Services perspective over a 12-month time horizon. Total costs, including smoking cessation, health-care and social services costs and quality-adjusted life years (QALYs), derived from the five-level EuroQol 5-dimension (EQ-5D-5 L), collected from a randomized controlled trial, were used as outcome measures. The bootstrap technique was employed to assess the uncertainty. **Setting** Sixteen primary care and 21 secondary care mental health sites in England. **Participants** Adult smokers with bipolar affective disorder, schizoaffective disorder or schizophrenia and related illnesses (n = 526). **Intervention and comparator** A bespoke smoking cessation (BSC) package for people with severe mental illness offered up to 12 individual sessions with a mental health smoking cessation practitioner versus usual care (UC). Of the participants who were randomized, 261 were in UC group and 265 were in BSC group. **Measurements** BSC intervention cost was estimated from the treatment log. Costs of UC, health-care and social services and EQ-5D-5 L were collected at baseline, 6- and 12-month follow-ups. Incremental costs and incremental QLAYs were estimated using regression adjusting for respective baseline values and other baseline covariates. **Findings** The mean total cost in the BSC group was £270 [95% confidence interval (CI) = –£1690 to £1424] lower than in the UC group, while the mean QALYs were 0.013 (95% CI = –0.008 to 0.045) higher, leading to BSC dominating UC (76% probability of cost-effective at £20 000/QALY). **Conclusions** A bespoke smoking cessation package for people with severe mental illness is likely to be cost-effective over 12 months compared with usual care provided by the UK's National Health Service and personal social services.

Keywords Cost-effectiveness, cost–utility, economic evaluation, severe mental illness, smoking cessation, tobacco use.

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INTRODUCTION

In 2018/19, Public Health England reported adult smoking prevalence in the general population as 14.5%, while in adults with long-term mental health conditions it was 26.8% [1]. The most recent estimate for smoking prevalence in adults with severe mental illness (SMI) was 40.5% in 2014/15 [1]. While the likelihood and intensity of smoking are higher in this population [2], smokers with SMI are less likely to receive help in quitting [3]. As

smoking is the most important modifiable risk factor in health, this contributes to the widening health inequality suffered by people with SMI [4].

Facing this challenge, the importance of smoking cessation in people with SMI has been stressed and relevant goals have been set out, but little guidance is provided on how to tailor smoking cessation services in the United Kingdom (UK) to cater for the needs of this population [5,6]. Trial-based evidence suggests that behavioural support and pharmacotherapies can be as effective in helping people with SMI to quit as the general population [7].

We conducted a 12-month pragmatic two-arm parallel group individually randomized controlled trial (RCT) to compare a bespoke smoking cessation (BSC) intervention (n = 265) with usual care (UC) (n = 261) (SCIMITAR+ trial). The report of the project has been published in full in health technology assessment [8]. The protocol has been published previously [9]. The carbon monoxide (CO)-verified quit rate at 6 month was 11% in the BSC group and 5% in the UC group, and at 12 months was 13% in the BSC group and 8% in the UC group [10]. The unadjusted odds ratio at 6 months was 2.4 [95% confidence interval (CI) = 1.3–4.7] and at 12 months was 1.6 (95% CI = 0.9–2.8). This article reports the analyses to (1) evaluate cost-effectiveness of BSC from a UK National Health Service (NHS) and Personal Social Services (PSS) perspective; and (2) observe if the costs of antipsychotic prescription change with smoking status.

METHODS

Study design

An incremental cost-effectiveness analysis was undertaken alongside the RCT to assess the cost-effectiveness of BSC in comparison with UC. The costs included smoking cessation treatment costs (BSC/UC) and health-care and social services costs. The effectiveness was measured in terms of quality-adjusted life years (QALYs). Ethical approval for the trial was granted by NRES Committee Yorkshire and The Humber–Leeds East REC (15/YH/0051) on 19 March 2015.

Intervention and comparator

The BSC intervention was a specialist smoking cessation package delivered by trained mental health smoking cessation practitioners (MH-SCPs), who were experienced mental health clinicians. The intervention was in line with the National Institute for Health and Care Excellence (NICE) guidelines [11] at the time of the trial and was delivered according to the Manual of Smoking Cessation developed by the National Centre for Smoking Cessation Training (NCSCT) [12] in the UK, with adaptations to cater for people with SMI [13]. It was developed and tested in the context of a feasibility RCT [14].

All participants remained under the care of their primary care physician and continued to receive routine care from mental health team. Participants allocated to the BSC group were offered up to 12 individual face-to-face support sessions with a MH-SCP (approximately 30 minutes each) in their home or NHS premises. MH-SCPs advised participants on available pharmacological smoking cessation aids and liaised with the participants' primary care physicians who would make decisions on prescribing pharmacotherapies chosen by participants. Participants allocated to the UC group were advised to seek help from their primary care physician and local Stop Smoking Service (SSS). No additional treatment was offered in the context of the SCIMITAR+ trial.

All participants had access to the full range of smoking cessation treatments offered by local authorities (LA) and the NHS. However, participants in the BSC group were asked not to take other treatments before the intervention ended.

Participants

Participants were recruited from 21 mental health trusts and 16 primary care sites in England, UK. Eligible participants were: people aged 18 years and above, with SMI, who smoked five or more cigarettes per day and expressed an interest in cutting down or quitting smoking. The adopted definition of SMI was a pragmatic one used in UK primary care, i.e. schizophrenia or delusional/psychotic illness (ICD-10: F20 X and F22 X) or bipolar disorder (ICD-10: F31 X) diagnosed by specialist mental health services and documented in either primary care records or psychiatric notes before recruitment. People who were pregnant or breastfeeding, had significant comorbid drug or alcohol problems (as ascertained by primary care physician or mental health worker), lacked capacity or were non-English speakers were excluded. Written consent was signed and dated by both participant and researcher at baseline.

Between October 2015 and December 2016, 265 participants were randomized to the BSC group and 261 to the UC group. The median age was 47.6 years [interquartile range (IQR) = 35.5, 55.3] in the BSC group and 46.6 years (IQR = 36.5, 53.8) in the UC group. Male participants consisted of 60% (159 of 265) of the BSC group and 58% (150 of 261) of the UC group. Five participants died before 6-month follow-up (three in BSC and two in UC) and two in the UC group died after 6-month follow-up.

Masking

Due to the nature of the intervention, it was not possible to blind participants, professionals involved in their care or researchers to treatment allocation.

Data collection

Costs

All costs are presented in 2016/17 pounds sterling (£).

Smoking cessation treatment cost. Costs of smoking cessation treatment consisted of cost of BSC intervention and cost of usual care for the BSC group, while only cost of usual care for the UC group. Cost of BSC intervention included cost of BSC training and supervision and cost of BSC delivery.

Four research staff took a 2-day training from the NCSCT and then delivered a 2-day training session in pairs, in line with the NCSCT to all MH-SCPs. The NCSCT training cost was estimated using the invoice. The time spent by research staff on the NCSCT training and on training MH-SCPs were costed at NHS band 6 to reflect the costs in practice (£43/hour) [15]. The time spent by the MH-SCPs was costed at NHS band 4 (£28/hour) [15]. These costs included salary on-costs, overheads and capital. A full working day was considered to be 7.5 hours. Each MH-SCP was given a 43-page manual and a 51-page NCSCT standard treatment programme. These were printed in-house at £0.02 per page. All MH-SCPs had regular supervision from those who delivered the training. Supervision time was recorded by the supervisors. Each MH-SCP was equipped with a £120 CO-monitor with a 5-year life-time. The depreciation value of CO-monitors in the first year was calculated using double-declining balance to estimate the cost of CO-monitors during the trial period. The total BSC training, supervision and materials costs were allocated to each participant in the BSC group.

The BSC delivery cost was estimated based on participants' sessions with MH-SCPs. The treatment costs in the BSC group further included contacts with usual care services for smoking cessation after BSC ended. In the UC group, the treatment costs were costs of contacts with usual care services for smoking cessation only.

The length and location of BSC sessions were recorded on treatment logs by MH-SCPs. An estimated 40 minutes was added to the sessions where the MH-SCPs had to travel to the appointment. An estimated 10 minutes was added to each attended session to account for administrative time. The costs of BSC delivery were calculated by multiplying the total hours spent by MH-SCPs by their hourly cost.

The costs of usual care services for smoking cessation included participants' contacts with primary care physicians, pharmacists, SSS, SSS helpline and prescriptions of pharmacotherapies for smoking cessation. The number of contacts with these services were collected using self-reported questionnaires at baseline, 6- and 12-month follow-up. It was then multiplied by a set of national average unit costs (Supporting information, Table S1) [15–17]. The data on prescribed pharmacotherapies during the trial period were extracted from participants' medical records and matched to the Prescription Cost Analysis England [18] by their generic name, dosage and form to gain a weighted average net ingredient cost (NIC) per unit, which was multiplied by prescribed quantities. If dosage or form was missing, a weighted average NIC matching available information was used instead. Medications that had been extracted by number of prescriptions were estimated based on weighted average NIC per prescription item.

Health-care and social services costs. Participants' use of health-care and social services was collected by an adapted Health Economic/Service Utilization questionnaire at baseline, 6- and 12-month follow-up, which covered service use for a 6-month period before each follow-up [19]. The services included primary care, secondary care and community-based services. The costs were estimated by multiplying the quantities by their national average unit costs extracted from secondary sources (Supporting information, Table S1) [15,20,21]. Participants' prescription of antipsychotics during the trial period was extracted, the costs of which were estimated using the same approach as with prescribed pharmacotherapies.

Quality-adjusted life years (QALYs)

The five-level EuroQol 5-dimension (EQ-5D-5 L) instrument was administered to all participants at baseline, 6- and 12-month follow-up, as recommended by NICE guidance [22]. It is a population preference-based measure of health-related quality of life, developed by the EuroQol Group [23], consisting of a descriptive system and a visual analogue scale (VAS). The descriptive system comprises five dimensions (mobility, self-care, usual activities, pain/discomfort and anxiety/depression), each with five levels (no problems, slight problems, moderate problems, severe problems and extreme problems). The complete set of five digits (one for each dimension) was converted to a utility score (−0.594 to 1) using the crosswalk mapping function based on the UK value set in line with the position of NICE at the time of analysis [24,25]. QALYs were then derived from utility scores at the three time-points by calculating the area under the curve [26]. The VAS has a range of 0 to 100, measuring the self-perceived health on the day.

Missing data

Any missing values in the baseline variables were imputed by the mean of the variable in the whole sample, as the amount of missingness was expected to be very low and to be independent of treatment allocation [27]. The missing values in the follow-up variables were handled by multiple imputation by chained equation (MICE) performed by allocation, assuming missing at random (MAR) [28]. Predictive mean matching was used as the imputation method

for continuous variables, using 10 nearest neighbours to the prediction as a pool from which to draw. Binary variables were imputed using the logit method. The imputation model included age, gender, study centre, existence of pre-existing medical condition, duration since first diagnosis of SMI, duration since start of smoking, cost of BSC training and supervision, cost of BSC delivery, cost of usual care services for smoking cessation, cost of pharmacotherapy prescriptions, cost of emergency and hospital services, cost of primary and community services, cost of antipsychotics prescription, cigarettes smoked per day, Fagerström Test for Nicotine Dependence (FTND), EQ-5D utility, EQ-5D VAS, travel expense, purchase of e-cigarettes and purchase of nicotine replacement therapy (NRT) products. As a rule of thumb, the number of imputations was set to the highest percentage of all missing values [28]. For those who died during the trial period, the costs, expenses, utility and EQ-5D VAS after the time of death were replaced with zero, while the missing values before the time of death were handled using the same imputation methods described above. The imputed data set was analysed following Rubin's rule [29].

Primary analysis

The primary analysis was conducted on an intention-to-treat basis from an NHS and PSS perspective, as per NICE guidance [22]. Neither costs nor QALYs were discounted, as the evaluation period was 12 months.

The total costs included smoking cessation treatment costs and health-care and social services costs over 12 months. The difference in mean total costs (incremental costs) and mean QALYs (incremental QALYs) between groups was estimated by a mixed-effect generalized linear model, using treatment group, age, gender, pre-existing medical condition, duration since first diagnosis of SMI as fixed effects and study centre as a random effect. For mean total costs, smoking cessation and health-care and social services costs in the 6 months before baseline were added as an additional covariate, and for mean QALYs utility value at baseline was added as an additional covariate [30]. Incremental costs and incremental QALYs were then assessed in combination. An incremental cost-effectiveness ratio (ICER) was calculated by dividing incremental costs by incremental QALYs where applicable. It was then compared with the maximum acceptable ICERs of £20 000–30 000, recommended by NICE [22].

The uncertainty surrounding incremental costs and QALYs was assessed using a non-parametric bootstrap technique, whereby 5000 replicate samples were generated by resampling [31]. Bootstrap was performed on the imputed data set for the primary analysis, using the methods described by Faria *et al*. [27]. Bootstrapped 95% CIs were estimated for incremental costs and incremental QALYs, respectively, while the combination of the two was plotted on a cost-effectiveness plane (CEP) to illustrate the uncertainty. Cost-effectiveness acceptability curves (CEACs) were constructed from the bootstrapped replicates by converting ICERs to net monetary benefit [32].

Sensitivity analyses

A complete case analysis (CCA) was undertaken to assess the impact of missing values and the uncertainty was assessed following the same approach used on the imputed data set. MAR assumption was assessed using the pattern mixture modelling approach [27] by assuming missing not at random (MNAR) mechanism, i.e. those who did not complete the service uses section of the questionnaire, had higher costs and worse health condition. This was examined after multiple imputation by varying imputed values, assuming: (1) imputed costs were increased by 10, 20 and 30% for those who did not complete services use section; (2) imputed QALYs were reduced by 10, 20 and 30% for those who did not complete EQ-5D-5 L.

Secondary analysis

There was evidence suggesting that smokers with SMI could reduce their intake of antipsychotics to achieve the same effect after they stop smoking [2]. To verify this, we conducted a before-and-after comparison of the costs of antipsychotics. Limited by the data availability, we used 6-month follow-up as the point of change. The costs of antipsychotics over 6 months before and after this point could then be compared by smoking status. The smoking status was classified to four categories: those quit at 6- and 12-month follow-ups, those quit at 6-month but not quit at 12-month follow-up, those not quit at 6-month but quit at 12-month follow-up and those quit at neither follow-up. Only those who provided valid smoking status information and whose cost of antipsychotics were available were included. The comparison was performed using Wilcoxon signed-rank test due to the non-normal distribution of the costs.

All analyses were performed using Stata version 15.0 SE.

RESULTS

Smoking cessation treatment costs

Fifty-six mental health clinicians attended the 2-day BSC training in eight groups. Supervision time was estimated at 30 minutes per participant. The mean BSC training, supervision and materials cost was £190 per participant in the BSC group (Table 1).

Two participants had records missing values on BSC sessions. Among the rest, the mean BSC delivery time was 492 minutes [standard deviation (SD) = 339,

Table 1 Breakdown of intervention training and supervision cost in the BSC group.

Item	*Description*	*Cost (2016/17)*	*Sources*
Training			
Staff time			
NCSCT training	–	£5325 in total	Invoice by NCSCT
Attending NCSCT training	7.5 hours/day × 2 days, 4 trainers (NHS band 6)	£43/hour per trainer	[13]
Training for MH-SCPs	7.5 hours/day × 2 days, 2 trainers (NHS band 6), 8 trainings held	£43/hour per trainer	[13]
Trainees (NHS band 4)	56 trainees attending 2 days training (7.5 hours/day)	£28/hour per person	[13]
Costs of staff time		£41 745 in total	
Printing			
Manual	43 pages/trainee	£0.02/page	Team records
Treatment programme	51 pages/trainee	£0.02/page	Team records
Cost of printing		£105 in total	
Costs of training		£158/participant	
Equipment			
CO monitor	56 × £120/device	£6720 in total	Team records
First year depreciation	Function life 5 years	£2688 in total	
Cost of CO monitor		£10/participant	
Supervision			
Supervisor (NHS band 6)	0.5 hours/participant	£43/hour	[13] Study estimates
Cost of supervision		£22/participant	
Total training, supervision and material costs		£190/participant randomized	

BSC = bespoke smoking cessation; NCSCT = National Centre for Smoking Cessation Training; MH-SCPs = mental health smoking cessation practitioners; NHS = National Health Service; CO = carbon monoxide.

range = 0–1425], including 27 participants who attended no sessions. The mean cost of BSC delivery was £229 (SD = £158) per participant in the 263 participants in the BSC group, with two participants missing.

The mean usage of usual care services for smoking cessation was less than once per responding participant within a 6-month period in both groups, and had a wide variance at individual level (Supporting information, Table S2). The mean cost of usual care services was £37 (SD = £60) among the 212 responding participants in months 1–6 and £26 (SD = £59) among the 213 responding participants in months 7–12 in the UC group. In the BSC group, it was £28 (SD = £62) among the 217 responding participants in months 1–6 and £23 (SD = £56) among the 212 responding participants in months 7–12.

The prescription information on pharmacotherapies for smoking cessation was returned for 160 of 261 (61%) participants in the UC group and 156 of 265 (59%) participants in the BSC group. The information was insufficient to extract NIC for four participants in the UC group and 17 participants in the BSC group, and their cost of pharmacotherapy prescription was considered missing. The mean cost of pharmacotherapy prescription was £26 (SD = £73) among the 156 participants in the UC group and £92 (SD = £198) among the 139 participants in the BSC group, including those for whom none were prescribed (115 of 156 in the UC group, 56 of 139 in the BSC group).

Missing data

At 6-month follow-up, 207 of 261 (79%) in the UC group and 208 of 265 (78%) in the BSC group completed the services use section of questionnaire (Pearson's χ^2 test, $P = 0.818$). At 12-month follow-up, 202 of 261 (77%) in the UC group and 203 of 265 (77%) in the BSC group did so (Pearson's χ^2 test, $P = 0.829$). The mean number of use of health-care services was generally low with a large standard deviation, except for primary care practice visits (more than two over 6 months), community psychiatric nurse (more than five over 6 months), Community Mental Health Team (more than four over 6 months) and day care service (more than three over 6 months) (Supporting information, Table S3). There were few missing data for baseline variables (≤ 2%). The highest percentage of missing values was 44% of the estimated costs of pharmacotherapy prescription due to the lack of or

insufficient data extraction from participants' medical records. The number of imputations was set to 45.

Primary analysis

The mean cost of smoking cessation treatment per participant, including BSC, usual care and pharmacotherapy prescriptions, was £93 [standard error (SE) = £9) in the UC group and £561 (SE = £19) in the BSC group. The mean total costs over 12 months were £8489 (SE = £775) in the UC group and £8447 (SE = £596) in the BSC group. The adjusted incremental costs were –£270 (95% CI = –£1690 to £1424). The mean QALYs over 12 months were 0.647 (SE = 0.017) in the UC group and 0.664 (SE = 0.015) in the BSC group. The adjusted incremental QALYs were 0.013 (95% CI = –0.008 to 0.045). This led to BSC dominating UC (less costly, more effective) (Table 2, left).

The upper part of Fig. 1 presents the CEP (left) and CEAC (right) constructed from 5000 bootstrapped replicates for the primary analysis. The CEP shows that the majority (4583 of 5000, 92%) of the estimated ICERs were to the right of the *y*-axis, indicating that BSC was likely to produce higher QALYs than UC. In the meantime, these estimates spread across the *x*-axis, indicating a higher level of uncertainty in the difference in total costs between the two groups. The CEAC shows that the probability of BSC being cost-effective, compared with UC, was 76% at £20 000/QALY and 80% at £30 000/QALY.

Sensitivity analyses

The CCA was performed on 168 participants (80 in the UC group and 88 in the BSC group). The results suggested that BSC was costlier than UC and more effective, but ICER indicates that BSC is not cost-effective compared with UC under current maximum acceptable ICERs at point estimate, with a very high level of uncertainty (Table 2, right; Fig. 1, lower). Figure 2 shows that the difference in mean values of both costs and utility between imputed data and complete cases was bigger in the UC group.

Under the MNAR assumption (1), the incremental costs became –£267, –£265 and –£263 when imputed costs were increased by 10, 20 and 30%, respectively. Under the MNAR assumption (2), the incremental QALYs became 0.014, 0.015 and 0.016 when imputed QALYs were decreased by 10, 20 and 30%, respectively. The BSC group retained dominance over the UC group.

Table 2 Incremental cost-effectiveness analysis results of the primary analysis and complete case analysis.

	Primary analysis		*Complete case analysis*	
	UC (n = 261)	*BSC (n = 265)*	*UC (n = 80)*	*BSC (n = 88)*
Costs	Mean (SE)		Mean (SD)	
BSC	–	£418 (£10)	–	£430 (£151)
Usual care services for smoking cessation	£65 (£6)	£52 (£6)	£63 (£88)	£53 (£98)
Pharmacotherapy prescription	£29 (£6)	£91 (£13)	£29 (£70)	£111 (£229)
Primary and community care	£4711 (£331)	£5101 (£383)	£5314 (£5101)	£5400 (£6068)
Secondary care	£2917 (£670)	£1986 (£397)	£2419 (£8791)	£1754 (£5238)
Antipsychotics prescription	£768 (£81)	£799 (£84)	£704 (£1268)	£587 (£654)
Total	£8489 (£775)	£8447 (£596)	£8530 (£11 405)	£8434 (£8642)
Incremental costs	Mean (95% CI)		Mean (95% CI)	
Adjusted difference in mean total costs[a]	–£270 (−£1690 to £1424)		£911 (−£2768 to £2631)	
Quality of life	Mean (SE)		Mean (SD)	
QALYs	0.647 (0.017)	0.664 (0.015)	0.615 (0.283)	0.679 (0.219)
Incremental QALYs	Mean (95% CI)		Mean (95% CI)	
Adjusted difference in mean QALYs[b]	0.013 (−0.008 to 0.045)		0.008 (−0.030 to 0.074)	
Incremental cost-effectiveness ratio	Mean (uncertainty)		Mean (uncertainty)	
ICER	BSC dominates (see Fig. 1 upper)		£113 875 (see Fig. 1 lower)	

[a]Adjusted for health resource use in the 6 months before randomization, age, gender, pre-existing medical conditions, duration since first diagnosis of severe mental illness (SMI), with study centre as random effect. [b]Adjusted for the five-level EuroQol 5-dimension (EQ-5D-5 L) utility value at baseline, age, gender, pre-existing medical conditions, duration since first diagnosis of SMI, with study centre as random effect. ICER = incremental cost-effectiveness ratio; QALY = quality-adjusted life year; CI = confidence interval; SE = standard error; SD = standard deviation; BSC = bespoke smoking cessation; UC = usual care.

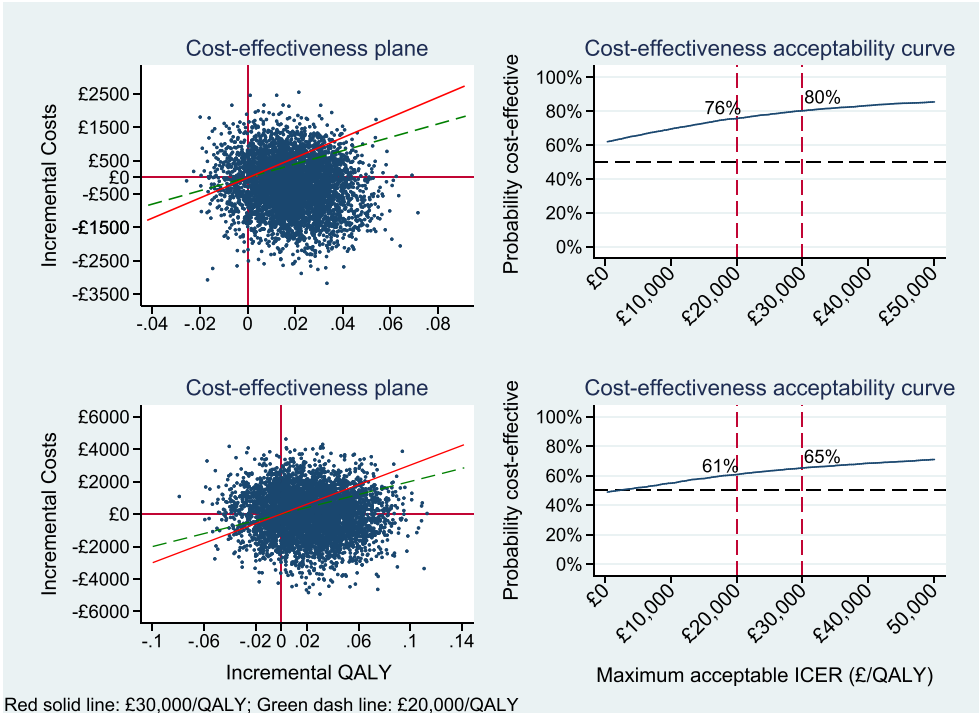

Figure 1 Cost-effectiveness plane (CEP) and cost-effectiveness acceptability curve (CEAC) of the primary analysis (upper) and the complete case analysis (CCA) (lower) [Colour figure can be viewed at wileyonlinelibrary.com]

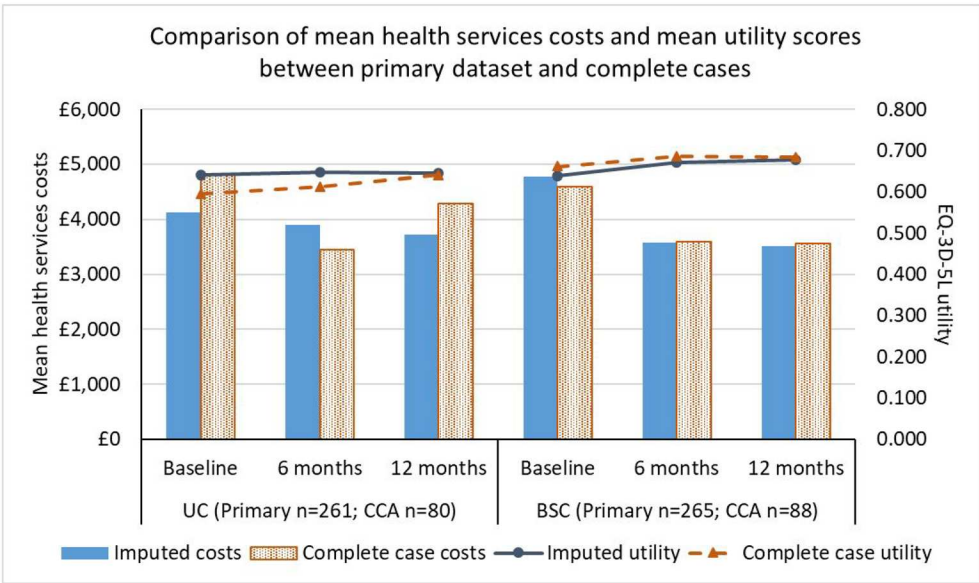

Figure 2 Comparison of mean health services costs and mean utility scores between primary data set and complete cases [Colour figure can be viewed at wileyonlinelibrary.com]

Secondary analysis

There were 344 participants who had CO-validated smoking status at both follow-ups and cost of antipsychotics during the trial period. No evidence of a change in antipsychotics costs between the two 6-month periods of the trial was found for the quitters. The non-quitters (n = 286) showed an increase in the cost of antipsychotics ($Z = 3.119$, $P = 0.0018$, Supporting information, Table S4).

DISCUSSION

The primary analysis found that the BSC intervention for people with SMI is likely to be cost-effective, compared with usual care, from an NHS and PSS perspective. Although the BSC intervention was more expensive than usual care and led to increased prescription of pharmacotherapies, this did not lead to an increase in overall NHS/PSS costs in the short term. The sensitivity analyses indicated that the impact of missing data was more prominent in the UC group than in the BSC group. The difference in mean cost of antipsychotics between the two halves of the trial period was not significant among those who had quit at either or both follow-up time-points. This might be due to the short time horizon and the limited number of quitters. However, there is a small but significant increase among those who continued to smoke. Although appearing unrelated to the BSC intervention, it pointed out that smoking cessation as a possible way to at least maintain the level of medication intake for smokers with SMI therefore strengthened the importance and potential benefits of quitting smoking in this population.

The strength of our trial stemmed from extensive data collection over health-care resources and the large sample size. To our knowledge, this is the first large-scale RCT with a concurrent economic evaluation of a bespoke intervention designed to help people with SMI to quit smoking. Previous trials have been limited by the sample size and short follow-up period, and focused more on pharmacotherapies than the behavioural support [7]. However, a 12-month follow-up period might still be insufficient for a smoking cessation intervention. In addition, with the large amount of data requested, the questionnaire became more complex and the burden of answering increased. This might contribute to the odd missing data at baseline. Given the low level of missing data the effect of using mean imputation should be minimal, but there was a potential modest underestimation of uncertainty as a result. We relied on the primary care practices to extract data from participants' medical records. While this improved the accuracy of prescription information, the withdrawal and closure of practices caused a considerable level of missing data, even with mental health trusts as an alternative data source.

As the complete case analysis is known to produce biased results, we used the multiple imputation method to deal with missing data. When undertaking bootstrap to assess the uncertainty of ICER for the imputed data set the method we used was suggested by Faria *et al.*, which performs bootstrap for each of the imputed data set [27]. Other methods such as drawing bootstrap samples from the incomplete data set and performing multiple imputation on each of the bootstrap samples have also been suggested [33]. The decision of which method to use might have affected the uncertainty assessment. However, this is beyond the scope of this study.

Although the use of crosswalk mapping function for EQ-5D-5 L was the requested method for the reference-case analysis stipulated by NICE [24], the uncertainty associated with mapping function itself is hard to account for in application. This conversion might also mitigate the possible benefits of the 5 L system [25]. Furthermore, the validity and responsiveness of EQ-5D-5 L in measuring people with severe mental illness such as bipolar disorder and schizophrenia have been called into question [34,35].

The primary analysis concludes that BSC is likely to be cost-effective due mainly to the lower costs of health resources use in this group, the main drive of which was lowered secondary care costs. This is consistent with what one study in the United States found, which indicated that tobacco cessation treatment for smokers hospitalized with psychiatric disorders may decrease rehospitalization risk due to the possible broader therapeutic benefit [36]. Instances were also observed where the MH-SCPs were able to identify early signs of decline in mental health and liaised with the mental health-care team for additional care. This is likely to have prevented further deterioration and the need for more intensive care.

Since undertaking the SCIMITAR+ trial, the way of commissioning smoking cessation services in England have changed and some services have been contracted-out to third parties. This might undermine the perspective taken in this study, as the reduced costs to the NHS would not be seen as a direct benefit.

More research is recommended to explore the integration of smoking cessation interventions with routine mental health services so as to maximize the benefits of intensive sessions. The long-term impact of smoking cessation among people with SMIs should also be studied, especially in relation to the use of antipsychotics, and the mechanism behind the lowered hospitalization for those who receive smoking cessation intervention.

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Clinical trial registration

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Declaration of interests

None.

Author contributions

Jinshuo Li: Formal analysis; methodology; visualization. **Caroline Fairhurst:** Data curation; methodology. **Emily Peckham:** Conceptualization; project administration. **Della Bailey:** Data curation; investigation. **Catherine Arundel:** Data curation; investigation; project administration. **Catherine Hewitt:** Conceptualization; funding acquisition; methodology; supervision. **Paul Heron:** Investigation; project administration. **Suzanne Crosland:** Data curation; project administration. **Steve Parrott:** Conceptualization; formal analysis; funding acquisition; methodology. **Simon Gilbody:** Conceptualization; funding acquisition; supervision.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Data S1 Supporting Information.

